

# GENERAL SERVICE LIGHTING

## REGULATORY PROPOSAL

PREPARED BY:

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SEPTEMBER 2016

COMMENTS MUST BE RECEIVED BY NOVEMBER 4, 2016

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**SCOPE AND REQUIREMENTS – REGULATORY PROPOSAL**

<b>TYPE OF DEVICE</b>	<p><b>General service lamps (GSL)</b> - commercially available lighting products for the purposes of general illumination. This category is technology independent, and includes incandescent lamps, compact fluorescent lamps (CFLs) and light-emitting diodes (LEDs).</p> <p>The proposed standard applies to each lamp that:</p> <ol style="list-style-type: none"> <li>(1) is intended for a general service or general illumination;</li> <li>(2) has a medium screw base or any screw base not defined in ANSI C81.61-2006, and;</li> <li>(3) is capable of being operated at a voltage at least partially within the range of 110 to 130 volts</li> </ol> <p>A more detailed scope of the proposed standard can be sourced from the federal definition of general service lamps, in addition to the federal definition of CFLs:</p> <p>GSLs: <a href="http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869">http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6869</a></p> <p>CFLs: <a href="http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6903">http://www.nrcan.gc.ca/energy/regulations-codes-standards/products/6903</a></p>
<b>TEST STANDARD</b>	<p><b>Incandescent lamps</b></p> <ul style="list-style-type: none"> <li>• <b>[Efficacy]</b> IESNA LM-45-15 Approved Method for the Electrical and Photometric Measurement of General Service Incandescent Filament Lamps</li> <li>• <b>[Life]</b> IESNA LM-49-01 Approved Method for Testing of Filament Lamps</li> </ul> <p><b>Compact fluorescent lamps (CFLs)</b></p> <ul style="list-style-type: none"> <li>• <b>[Efficacy]</b> <ul style="list-style-type: none"> <li>○ CAN/CSA-C861-10 (R2015) - Performance of self-ballasted compact fluorescent lamps and ballasted adapters, <b>OR</b></li> <li>○ IESNA LM-66-14 Electrical and Photometric Measurements of Single-Based Fluorescent Lamps</li> </ul> </li> <li>• <b>[Life]</b> IESNA LM-65-14 Life Testing of Single-Ended Compact Fluorescent Lamps</li> </ul> <p><b>Light-emitting diode (LED) lamps</b></p> <ul style="list-style-type: none"> <li>• <b>[Efficacy]</b> IESNA LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products</li> <li>• <b>[Life]</b> <ul style="list-style-type: none"> <li>○ IESNA LM-84-14 Approved Method: Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires, <b>AND</b></li> <li>○ IESNA TM-28-14 Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires</li> </ul> </li> </ul> <p><b>All GSLs: Colour Rendering Index (CRI)</b></p> <ul style="list-style-type: none"> <li>• CIE 13.3-1995 Method of Measuring and Specifying Colour Rendering</li> </ul>

	Properties of Light Sources
<b>PROPOSED ENERGY PERFORMANCE STANDARD</b>	<p>The following items outline the <b>mandatory criteria</b> of this proposal:</p> <ol style="list-style-type: none"> <li>(1) Minimum efficacy: 45 lumens per watt (LPW)</li> <li>(2) Minimum colour rendering index (CRI):               <ol style="list-style-type: none"> <li>(a) 80 for non-modified spectrum lamps, or</li> <li>(b) 75 for modified spectrum lamps</li> </ol> </li> <li>(3) Minimum rated life: 1, 000 hours</li> </ol> <p>At current levels of technology, the proposed standard will effectively eliminate halogen-infrared (HIR) GSLs from the marketplace.</p>
<b>EFFECTIVE DATE</b>	Products manufactured and sold after January 1, 2018
<b>CERTIFICATION</b>	<p>Compliance with the proposed regulation will be based on testing and verification by Standards Council of Canada accredited Certification Organizations on adherence of manufactured products with the “Proposed Energy Performance Standard” using the proposed "test standard".</p> <p>No unique British Columbia label will be required for products where the following is listed on the packaging:</p> <ol style="list-style-type: none"> <li>(a) Wattage</li> <li>(b) Lumens</li> <li>(c) CRI</li> <li>(d) Rated life</li> </ol>
<b>NEED FOR REGULATION</b>	The proposed standard reduces energy costs for consumers, improving the affordability of houses and buildings. The standard supports the Province’s energy objectives under the <i>Clean Energy Act</i> , including the target for BC Hydro to meet 66% of electricity demand growth through demand-side measures by 2020.
<b>HARMONIZATION</b>	This regulatory proposal harmonizes with the Ontario Ministry of Energy GSL standard that came into effect in 2015 and the California Energy Commission GSL standard that becomes effective on January 1, 2018. The standard will preclude B.C. from becoming a ‘dumping ground’ for less efficient products and supports the <i>2016 Pacific Coast Collaborative Climate Leadership Action Plan</i> commitment to harmonize product energy efficiency standards across the region.
<b>TRANSPARENT REGULATION DEVELOPMENT</b>	<p>Development of the regulation proceeded as follows:</p> <ul style="list-style-type: none"> <li>• Initial market analysis in B.C.</li> <li>• Economic assessment</li> <li>• Regulatory assessment</li> </ul> <p>A stakeholder consultation will be held during a 5-week public review period.</p>
<b>MARKET TRANSFORMATION ACTIVITY &amp; INDICATORS</b>	<p><b>Overview:</b> In 2011, B.C. introduced a GSL regulation that eliminated traditional incandescent bulbs in the 100W and 75W categories. On January 1<sup>st</sup>, 2014, Natural Resources Canada (NRCAN) introduced an identical federal GSL regulation in the 100W and 75W category, which expanded on December 31<sup>st</sup>, 2014 to cover traditional incandescent bulbs in the 60W and 40W categories. In effect, the NRCAN regulations leave CFL, LED, and HIR technologies as 40-100W GSL replacement</p>

**MARKET  
TRANSFORMATION  
ACTIVITIES &  
INDICATORS**

products.

A combination of regulation, market transformation initiatives (detailed below) and market evolution over the past 5 years has significantly shifted the GSL market towards LEDs. LEDs now represent an estimated 34% of GSL shipments, followed by CFLs at 22% and halogens at 2% as illustrated in Figure 3 (BC Hydro, 2016). The remaining 42% is likely accounted for by incandescent GSLs, due to manufacturers shipping old stock manufactured before the effective dates cited in NRCan’s regulation.

**Availability:** Data from a BC Hydro Product Survey Report completed in 2015 showed that LED and CFL replacements for GSLs are offered by the four major lighting manufacturers: Philips, Osram/Sylvania, GE, and Standard Products. The study found that on average, CFLs and LEDs accounted for approximately 67% of shelf space dedicated to GSLs.

**Awareness:** From a marketing perspective, B.C. utilities and retailers continue to promote the benefits of LED lighting via advertisement campaigns and retail store displays. ENERGY STAR® designated lighting products, primarily LEDs, have built public awareness of high performance lighting options.

**Accessibility:** LED and CFL GSLs are offered in a variety of wattages at all major retailers, including:

- Home Depot
- Rona
- Canadian Tire
- Costco
- Walmart
- London Drugs
- Superstore
- Safeway
- Save-On
- Lowe’s

**Affordability:** The incremental cost of LED and CFL bulbs is offset by energy savings and durability. LED bulbs are two to six times more expensive than HIR bulbs, but have a lifespan that is eight times longer. CFLs are 40% more expensive than HIR bulbs but have a lifespan that is 2.5 times longer. See page 7 for costing details.

**Acceptability:** LED bulbs are now generally accepted as comparable alternatives to incandescent bulbs. Early LED technology suffered from concerns surrounding poor colour rendering index (CRI), harsh “white” light, and incompatibility with dimmers. Over the last five years there have been a multitude of bulbs introduced with higher CRIs, alleviating these concerns. Additionally, LEDs are now largely dimmable. Likewise, correlated colour temperature (CCT) is commonly reported on product packaging to allow users to select the hue of the bulb’s emanated light.

CFLs are generally considered to be a second choice behind LEDs by consumers due to a shorter lifetime, and concerns surrounding flicker, narrow selection of CCT and CRI, as well as the perceived hazard of mercury contamination from a broken bulb. Still, some consumers prefer CFLs over LEDs due to lower purchase costs.

	<p><b><i>Demand Side Management (DSM) programs to increase market share:</i></b> BC Hydro has provided consumer rebates for LED and CFL GSLs at retailers twice a year since the early 2000's, discounting retail prices by approximately 25%.</p> <p>This proposed regulation can be promoted by energy utilities through their Demand-Side Management (DSM) programs, leading to increased market share of compliant products prior to the effective date. In turn, part of the energy savings from the proposed regulation can be attributed back to those DSM programs as per Section 4 (Subsection 1.4) of the Demand-Side Measures Regulation under the <i>Utilities Commission Act</i>:</p> <p><a href="http://www.bclaws.ca/Recon/document/ID/freeside/10_326_2008">http://www.bclaws.ca/Recon/document/ID/freeside/10_326_2008</a></p>
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## ASSESSMENT FROM AN INDUSTRY PERSPECTIVE

<p><b>RANGE OF PRODUCTS AFFECTED</b></p>	<p>The proposed regulation affects the manufacture and sale of GSLs in British Columbia. The proposed regulation would only apply to products manufactured <b>after</b> the proposed effective date. Retailers that are selling inventory that is manufactured before the proposed effective date can continue to do so.</p>
<p><b>COST IMPACT</b></p>	<p>Retailers can expect to be selling more expensive 'premium' products in the short term. As LEDs have a lifetime of greater than 20 years, annual unit sales for retrofit scenarios are expected to decrease over time. CFLs will become the cheapest replacement product available through retail channels, albeit with a shorter lifetime than LEDs (typically 5-8 years).</p>
<p><b>JURISDICTIONAL SCAN &amp; COMPETITIVE ANALYSIS</b></p>	<p>On January 1, 2014 and December 31, 2014, NRCan introduced a federal GSL regulation, aligned with the United States Department of Energy (U.S. DOE), eliminating traditional incandescent bulbs in the 75-100W and 40-60W categories respectively. The NRCan regulation allows for HIR bulbs to meet the standard. In 2015, the Ontario Ministry of Energy introduced a GSL standard eliminating HIR GSLs. California has adopted an identical standard, effective on January 1, 2018. The U.S. DOE published a Notice of Proposed Rulemaking (NOPR) for GSLs On March 17, 2016. If adopted, it will effectively phase-out CFLs January 1, 2020.</p> <p>The proposed B.C. GSL standard is identical to the standard adopted by Ontario and California. Harmonization will simplify compliance for manufacturers.</p> <p><b>Figure 1</b> illustrates the landscape of current and proposed GSL standards:</p>

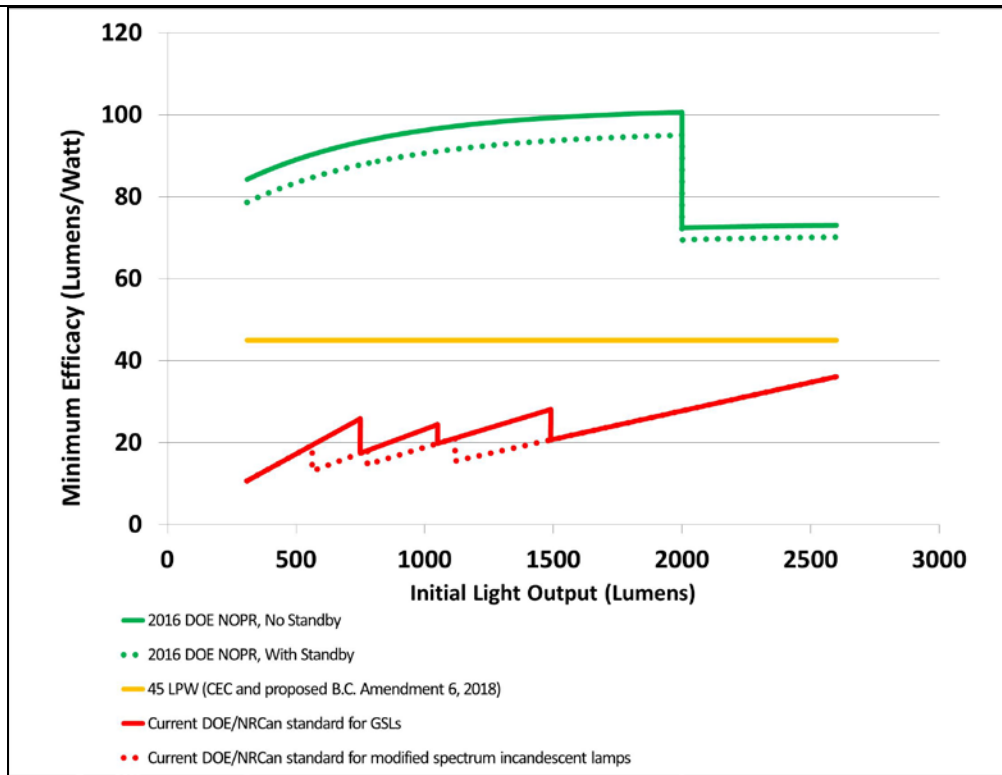


Figure 1: A visual representation of key GSL standards (current and proposed)

A 2015 BC Hydro Product Survey Report analyzed the current stock of common GSLs in the province. **Figure 2** illustrates how GSLs perform relative to current and proposed standards:

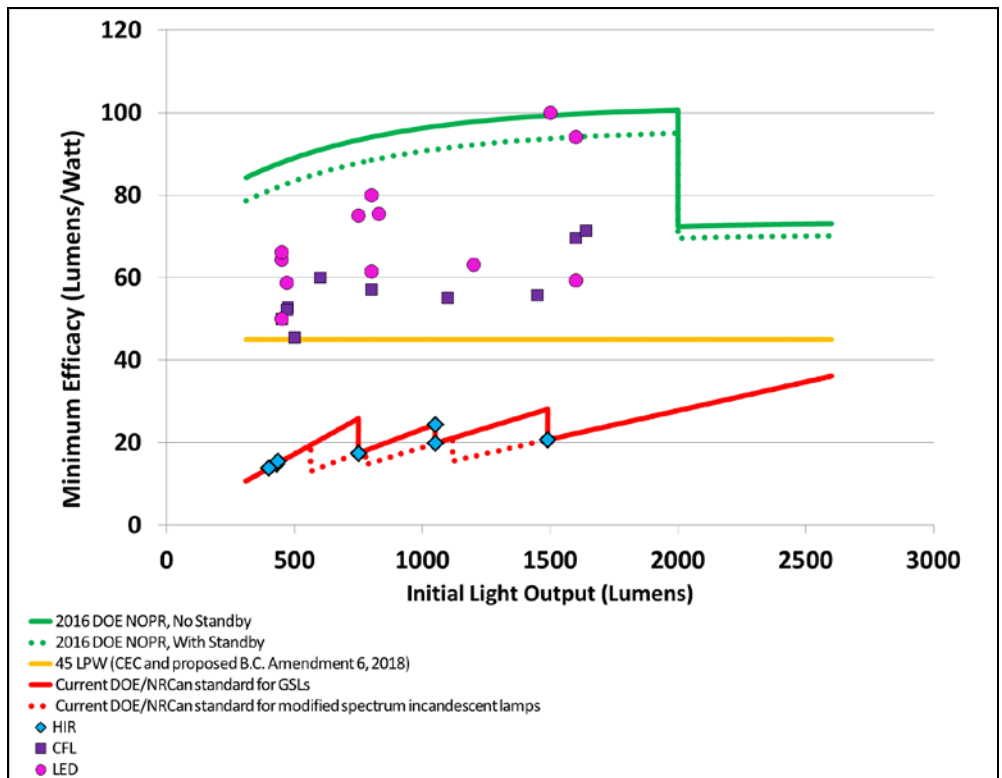


Figure 2: An illustration of how GSLs in the market perform relative to current and proposed standards

**MARKET SHARE**

Aggregated 2015 and 2016 shipment data to distributors mainly serving B.C. commercial and multi-unit residential sectors was obtained from the four main North American manufacturers (Philips, Osram/Sylvania, GE, and Standard Products) (Figure 3). The data illustrates that incandescent and halogen shipments are falling rapidly, and that LEDs are the preferred replacement product.

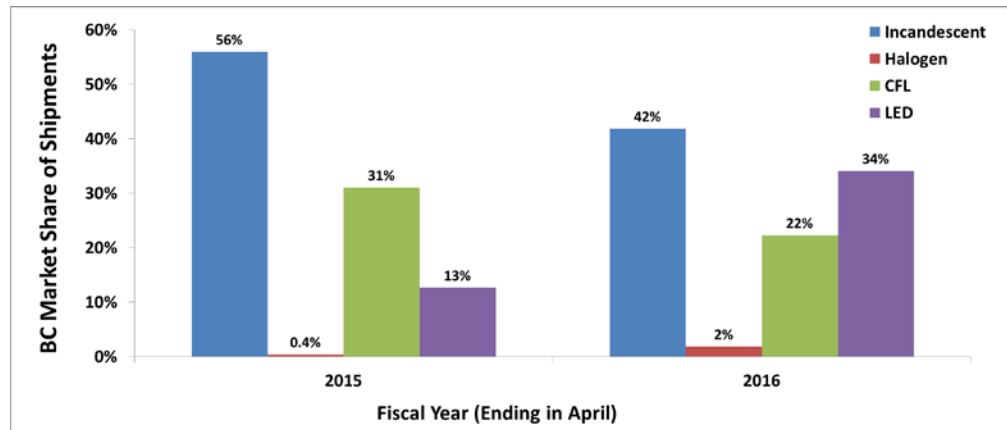


Figure 3: B.C. shipment data to the commercial and multi-unit residential sector in 2015 and 2016 (BC Hydro, 2016)

**ASSESSMENT FROM A CONSUMER PERSPECTIVE**
**INCREMENTAL  
PURCHASE COSTS**

Costing data from a BC Hydro Product Survey Report (sourcing 2014 data) is summarized in Table 1:

Equivalent Power Consumption (W)	Incandescent		Halogen			CFL			LED		
	Price (\$)	Lifetime (hrs)	Power Consumption (W)	Price (\$)	Lifetime (hrs)	Power Consumption (W)	Price (\$)	Lifetime (hrs)	Power Consumption (W)	Price (\$)	Lifetime (hrs)
100	2.00	1000	72	2.62	1000	23	4.57	8000	18	23.66	25000
75	2.00	1000	53	2.62	1000	20	4.57	8000	13	23.66	25000
60	1.00	1000	43	2.44	1000	14	3.61	8000	10	14.71	25000
40	1.00	1000	29	2.83	1000	9	2.70	8000	6	9.00	25000

Figure 4: 2014 B.C. data on retail product costs per technology

Ministry of Energy and Mines staff additionally surveyed four major Victoria-area retailers in 2016 and found that unit prices for 60W equivalent LEDs have dropped on average to \$5 per bulb, representing a 66% decrease in price over the last 2 years.

As costs are decreasing dramatically for LEDs, it is expected that the incremental cost by 2018 will be comparable to CFLs.

For the purpose of this regulatory analysis, incremental cost was calculated to be \$1.02, based on the weighted average cost difference between HIR and CFL bulbs. CFLs will become the baseline for minimum efficiency under the proposed regulation.

<b>DATA AND ASSUMPTIONS</b>	<ul style="list-style-type: none"> <li>• Economic analysis included BC Hydro Residential Inclining Block (RIB) rates, with 60% tier 1 rates and 40% tier 2 rates <ul style="list-style-type: none"> <li>○ tier 1 rate in 2018: \$0.0902/kWh</li> <li>○ tier 2 rate in 2018: \$0.1306/kWh</li> </ul> </li> <li>• Average energy consumption of a &lt; 45 L/W halogen lamp: 42 kWh/yr</li> <li>• Average cost of a &lt; 45 L/W halogen lamp: \$2.61</li> <li>• Average expected life of a &lt; 45 L/W halogen lamp: 3.2 years</li> <li>• Average energy consumption of a 45 L/W CFL lamp: 14 kWh/yr</li> <li>• Average cost of a 45 L/W CFL lamp: \$3.63</li> <li>• Average expected life of a 45 L/W CFL lamp: 8.5 years</li> <li>• consumer discount rate is 6%</li> </ul>										
<b>COST-BENEFIT ANALYSIS</b>  <b>ENERGY SAVINGS FOR EACH CONSUMER</b>	<p>An economic model using the above data and assumptions yielded the following results:</p> <table border="1" data-bbox="440 758 1481 1098"> <tr> <td style="text-align: center;">Energy savings per unit</td> <td style="text-align: center;">28 kWh/year</td> </tr> <tr> <td style="text-align: center;">Cost savings per unit</td> <td style="text-align: center;">\$3.04</td> </tr> <tr> <td style="text-align: center;">Simple payback per unit</td> <td style="text-align: center;">0.3 years</td> </tr> <tr> <td style="text-align: center;">NPV of consumer cost savings per unit, full equipment life, including PST/GST</td> <td style="text-align: center;">\$23.60</td> </tr> <tr> <td style="text-align: center;">Consumer NPV per unit, including PST/GST</td> <td style="text-align: center;">\$22.46</td> </tr> </table>	Energy savings per unit	28 kWh/year	Cost savings per unit	\$3.04	Simple payback per unit	0.3 years	NPV of consumer cost savings per unit, full equipment life, including PST/GST	\$23.60	Consumer NPV per unit, including PST/GST	\$22.46
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<b>NON-ENERGY BENEFITS</b>	<p>LEDs and CFLs generally emit less heat than halogens. In certain applications it can be advantageous to minimize heat gains in buildings and homes to ensure thermal comfort, maximize energy efficiency of an existing heating system, and minimize air conditioning load on hot days and/or in warmer climates.</p> <p>LEDs and CFLs require less frequent replacement than HIRs, with an average life of 20+ years in the case of LEDs and 5-8 years in the case of CFLs, compared to approximately 1-3 years for HIRs.</p>										



**ASSESSMENT FROM A PROVINCIAL GOVERNMENT PERSPECTIVE**

<p><b>ECONOMIC ASSESSMENT FROM A PROVINCIAL PERSPECTIVE</b></p> <p><i>(Aggregate energy, emission and net cost savings)</i></p>	<p>A province wide impact assessment considers the following additional assumptions and trends:</p> <ul style="list-style-type: none"> <li>• In the reference case, halogen lamps &lt; 45 L/W represent 13% of installed units in 2015, 6.7% in 2018.</li> <li>• In the reference case, total GSL lamps sold in B.C. are 33M in 2015 and 9M in 2018. The reason for the sharp decline in sales over this period is the replacement of incandescent lamps with longer-lasting CFLs and LEDs</li> <li>• Long run marginal cost (LRMC) of electricity: \$0.1034/kWh</li> <li>• Provincial and consumer discount rates: 6%</li> <li>• Utility discount rate: 5%</li> </ul> <p>The following three metrics illustrate the benefit of the regulation from an energy, cost, and provincial Net Present Value (NPV) perspective:</p> <table border="1" data-bbox="431 787 1437 1115"> <tr> <td>Cumulative Energy Savings 2018-2025</td> <td>109 GWh/yr</td> </tr> <tr> <td>Cumulative Cost Savings in 2025</td> <td>\$12M</td> </tr> <tr> <td>Provincial NPV (\$) over the lifetime of products installed between 2018-2025, with energy benefits</td> <td>\$85M</td> </tr> </table> <p>In summary, British Columbians as a whole will see 109 GWh/yr of savings in 2025, resulting in \$12 million of annual energy savings. The province will benefit from an \$85 million NPV over the lifetime of products installed between 2018 and 2025.</p>	Cumulative Energy Savings 2018-2025	109 GWh/yr	Cumulative Cost Savings in 2025	\$12M	Provincial NPV (\$) over the lifetime of products installed between 2018-2025, with energy benefits	\$85M
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<p><b>ADMINISTRATIVE FEASIBILITY FOR COMPLIANCE AND ENFORCEMENT</b></p>	<p>Compliance and enforcement under the <i>Energy Efficiency Act</i> is based on random inspections and response to compliance complaints. Enforcement will rely upon comparisons of product packaging with certification reports.</p>						

**NOTES**

<p><b>REGULATORY ASSESSMENT COMPLETED BY</b></p>	<p>Voytek Gretka, M.Eng, CEM, EIT Tel: (250) 952-0626 E-mail: Voytek.Gretka@gov.bc.ca</p>
<p><b>DATE</b></p>	<p>September, 2016</p>